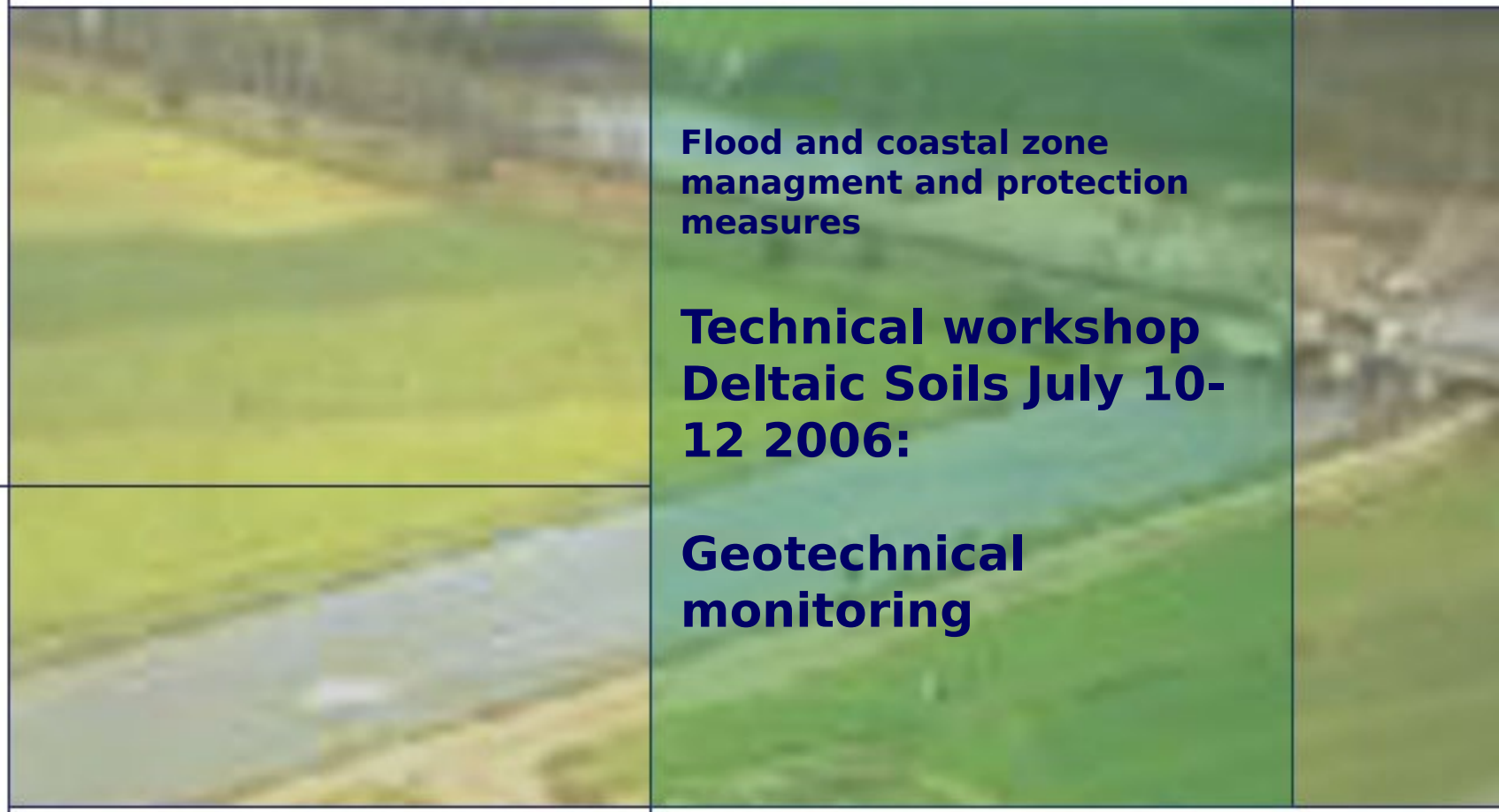


Flood and coastal zone managment and protection measures

Technical workshop Deltaic Soils July 10-12 2006:

Geotechnical monitoring

Mario Weinberg

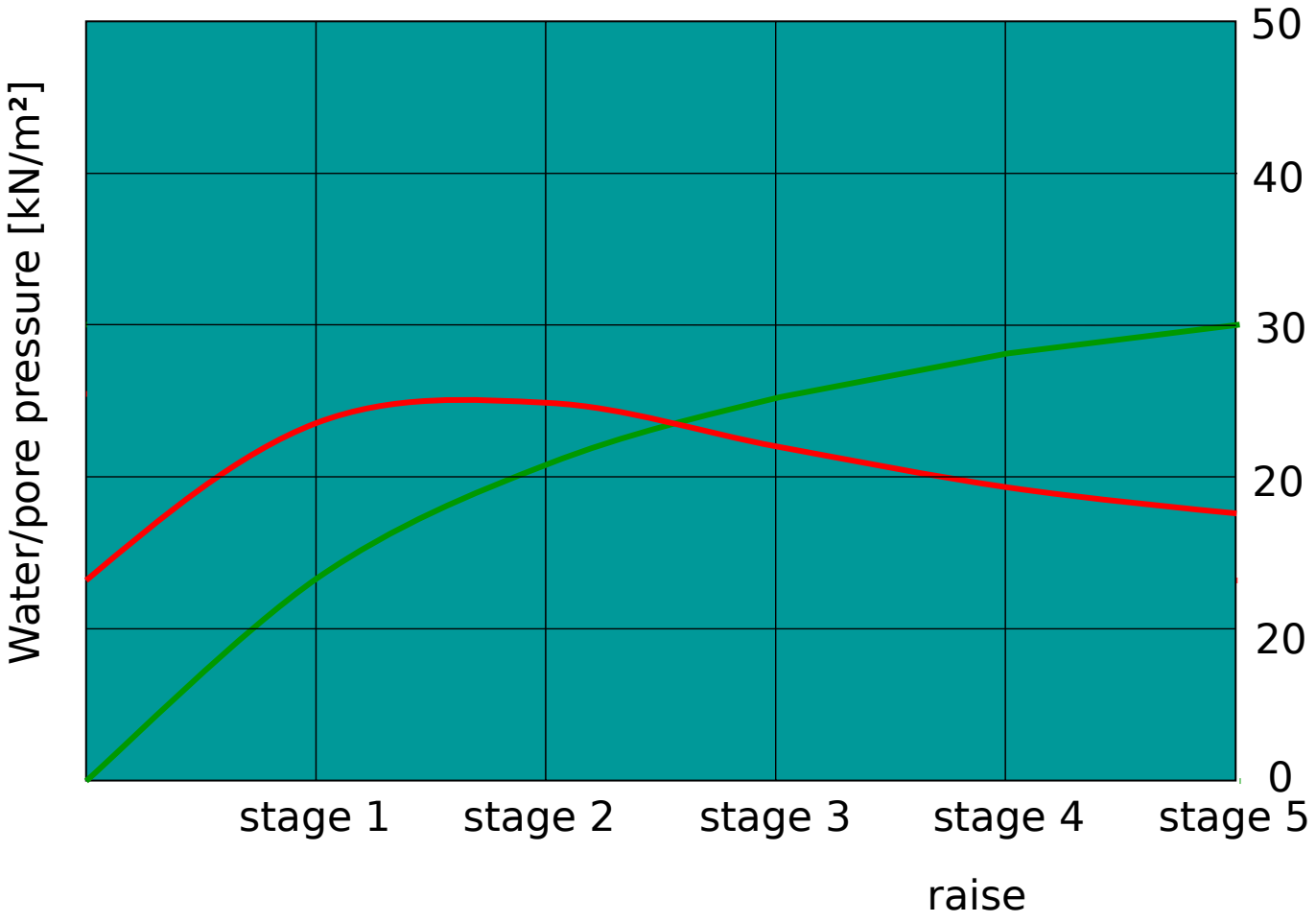
GeoDelft

- **Geotechnical monitoring consists of:**
  - Monitoring stability embankments
    - optimizing speed staged construction
  - Measuring settlements
    - determining amount of fill
    - determining residual settlements
    - monitoring surrounding area
  - Measuring horizontale deformation
    - monitoring surrounding area

- **Stability embankments**
  - Water/pore pressures
  - Effective pressures
  - Ground/total pressures
  - Shear strength
  - Consolidation (c_v)
  - Excess water/pore pressures
  - Cohesion (c)
  - Angle of internal friction (φ)

- **Stability embankments**
  - Embankment on soft soil (clay and peat)
    - initialy water/pore pressures carry the load of the embankment. Loading increases, strenght remains the same. With to much loading risk of overloading
    - second stage consolidation appears

‘Red and Green lines’



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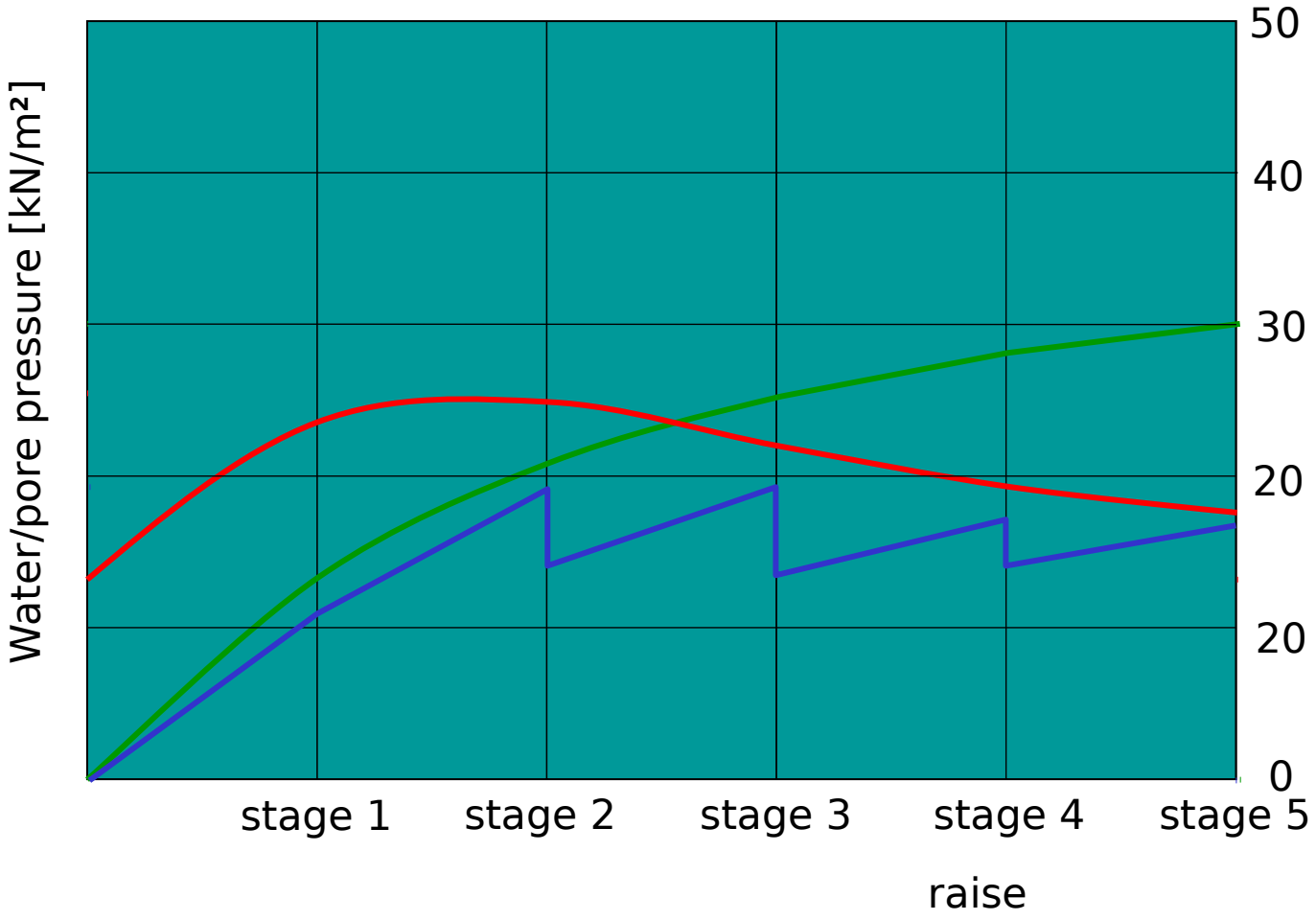

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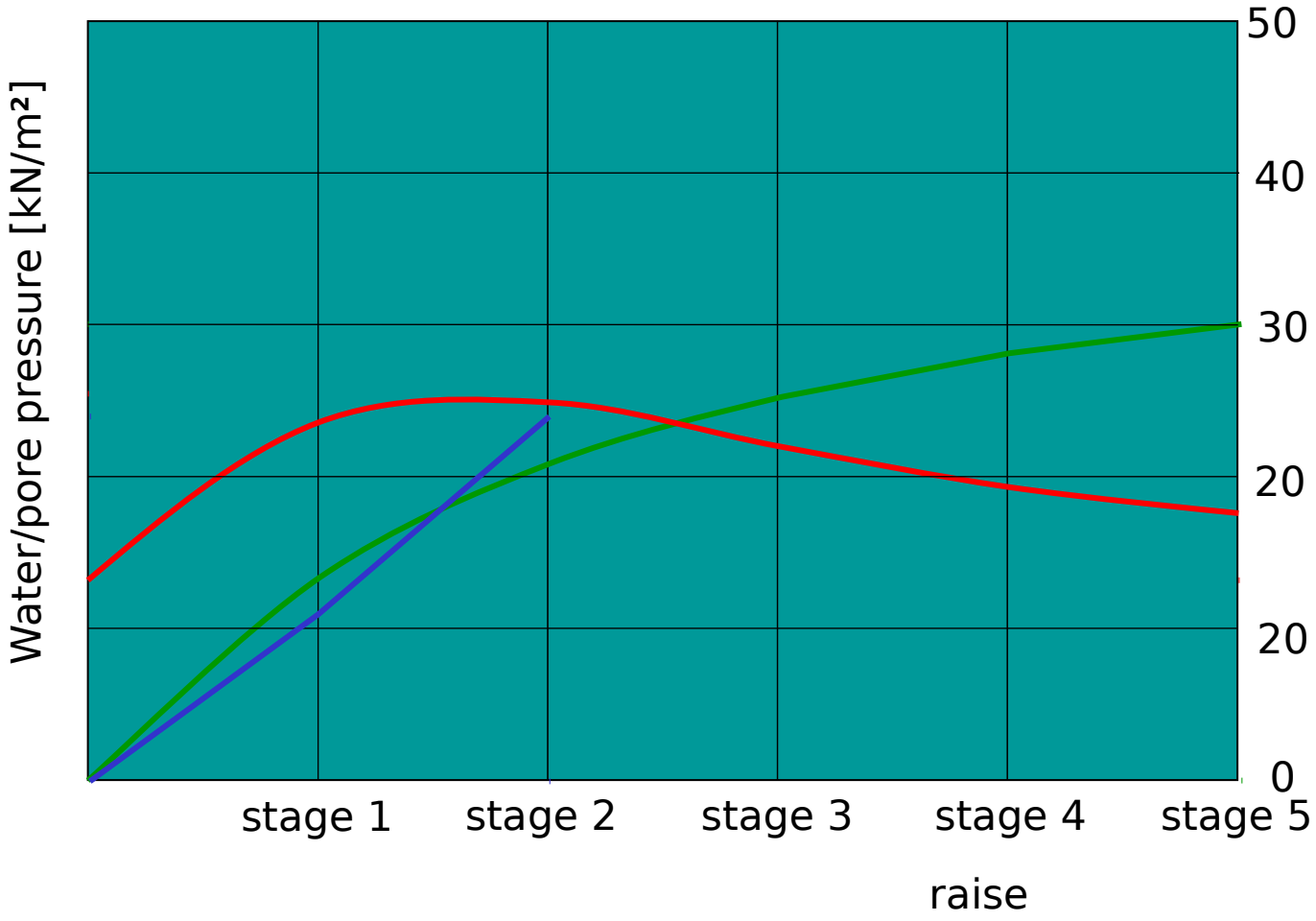

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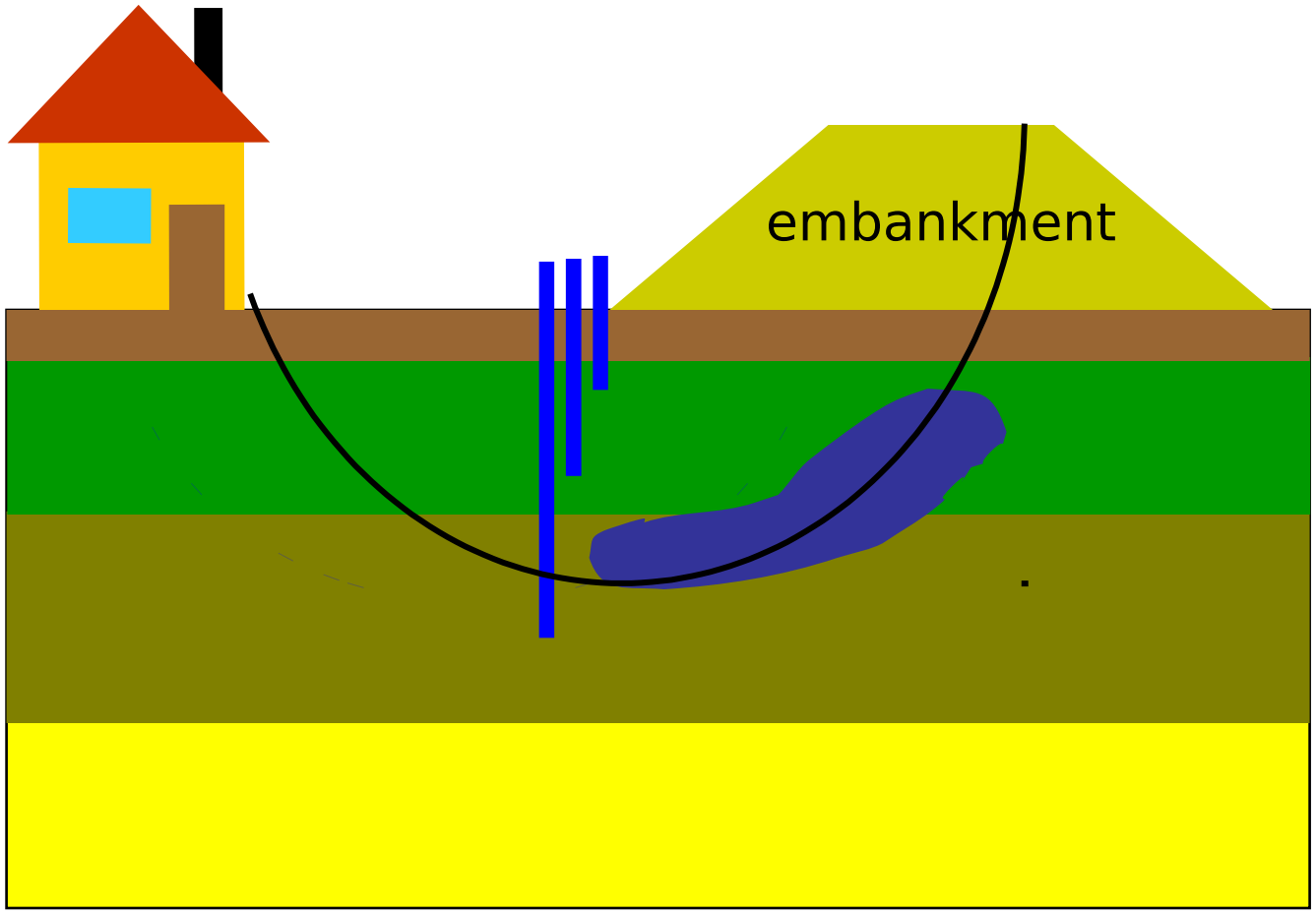

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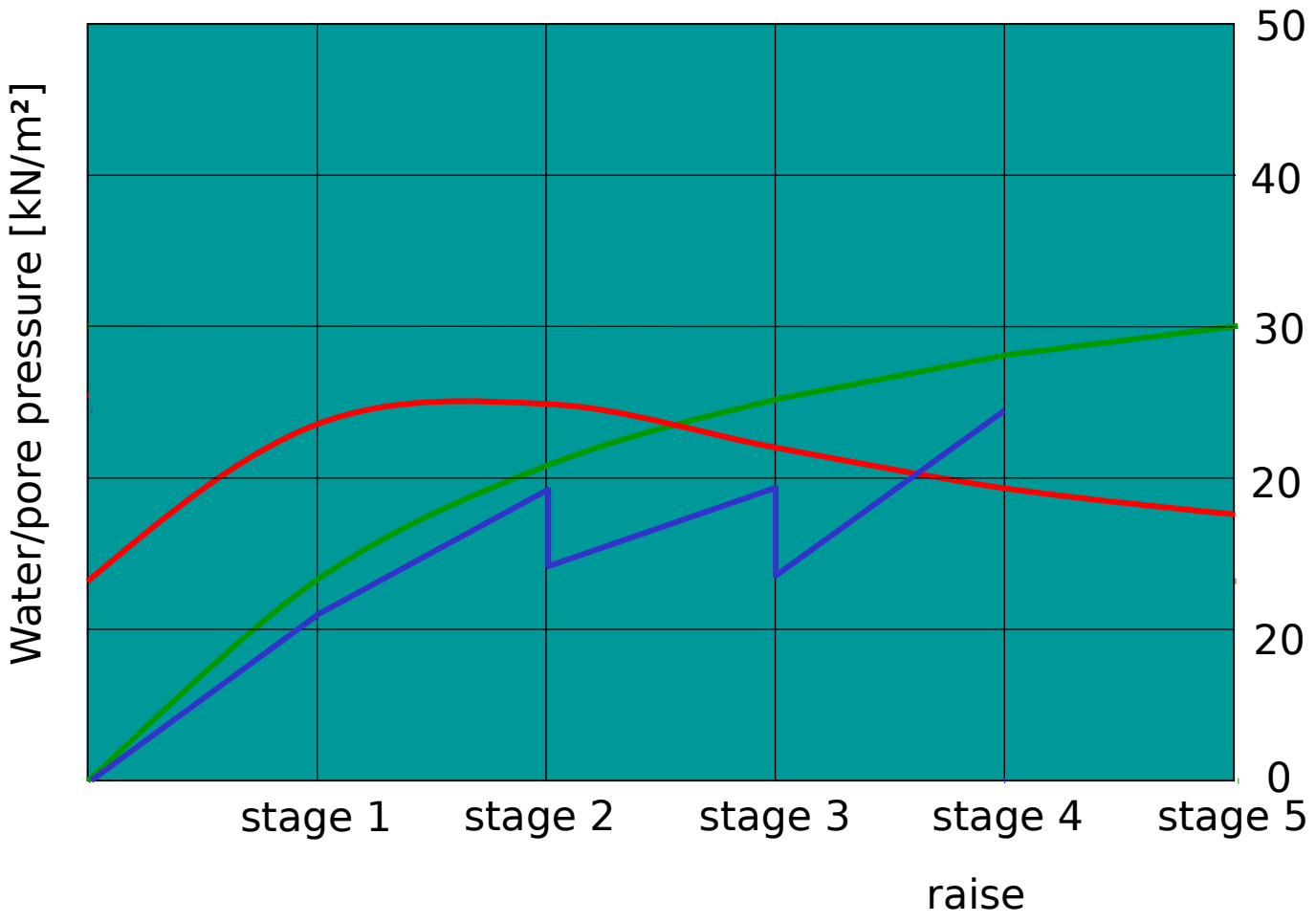

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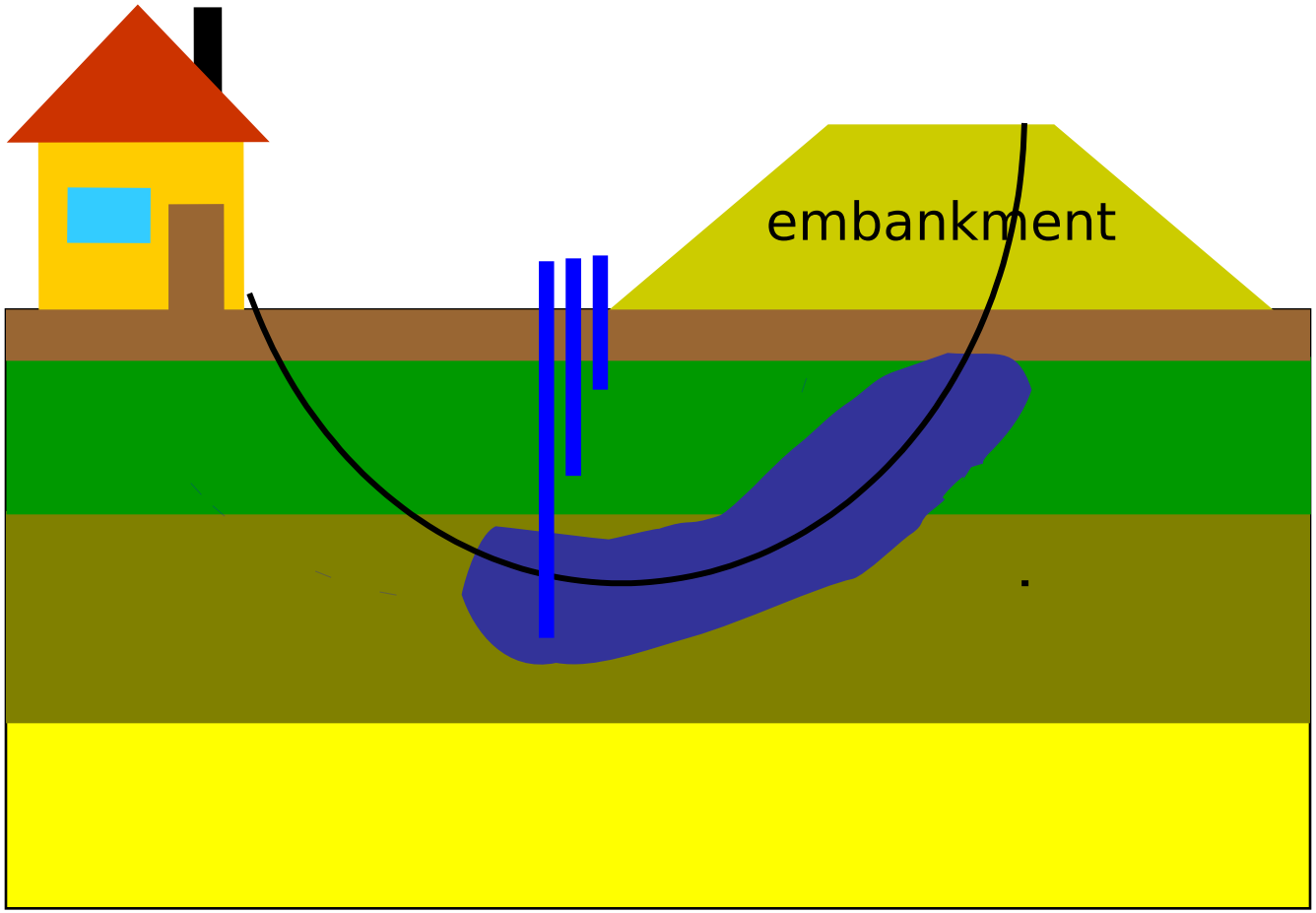

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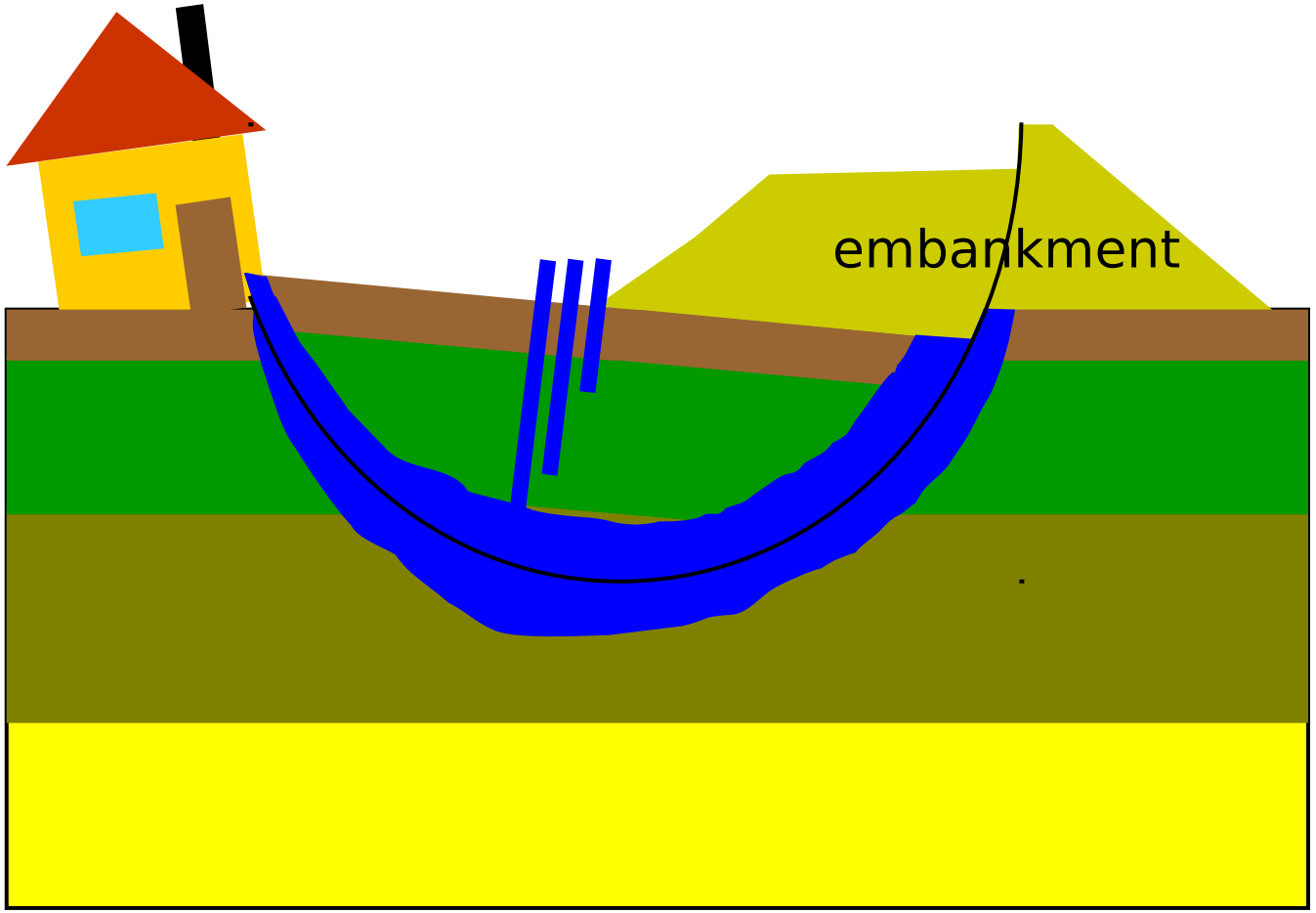
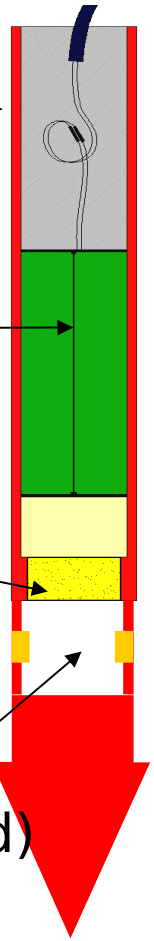


- **Instruments to measure water/pore pressure**
  - Vibrating Wire Piezometer (VWP)
  - Piezo Resistive meter (PR)
  - Bourdon

Vibrating Wire Piezometer



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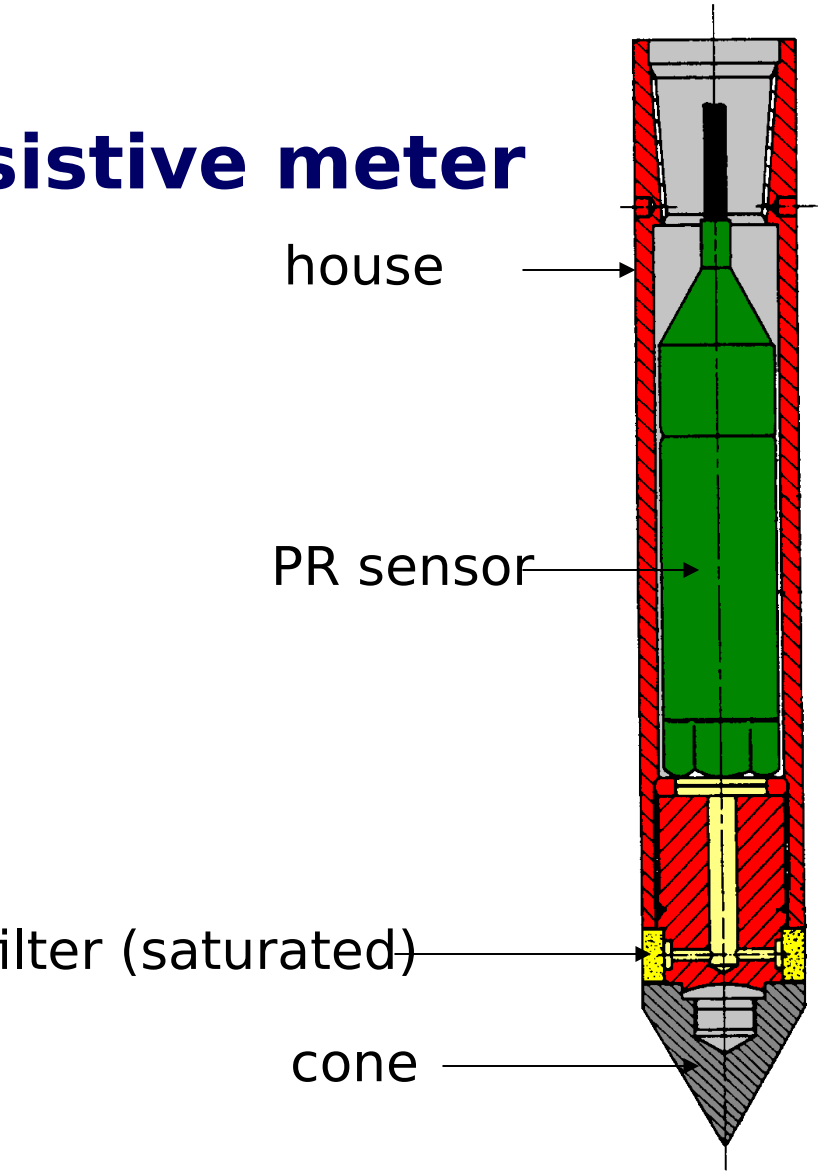
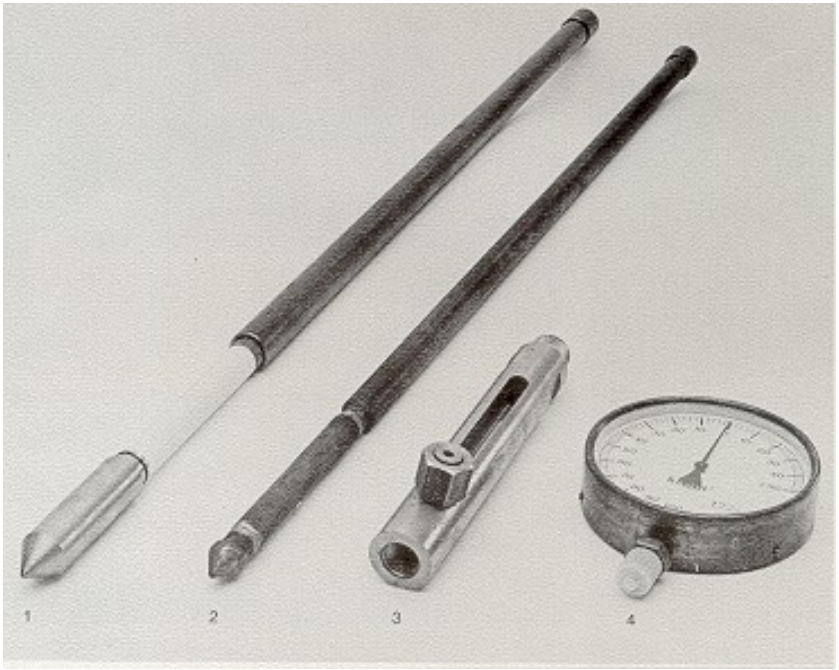
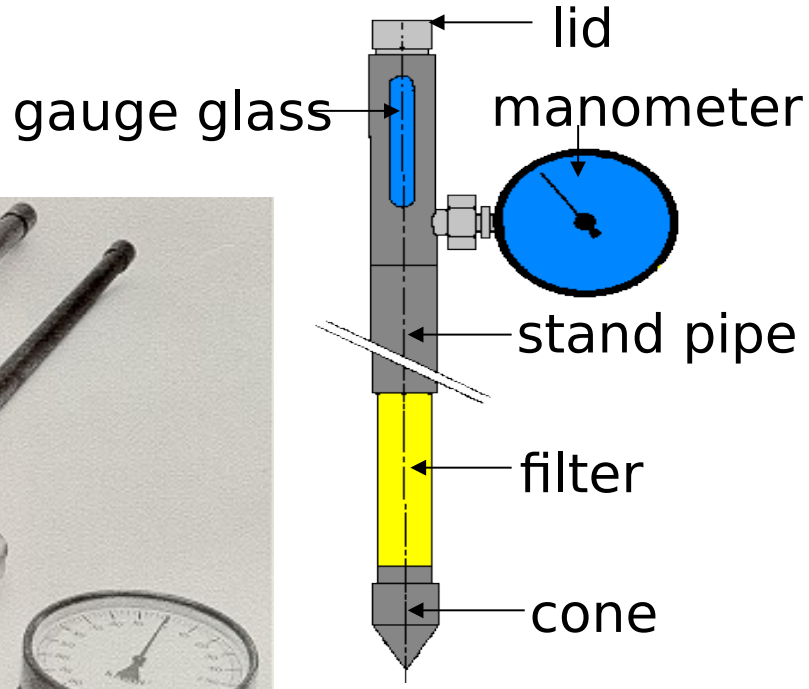
- **Piezo Resistive meter**



- **Bourdon**





- **Characteristics water/pore pressure meters**

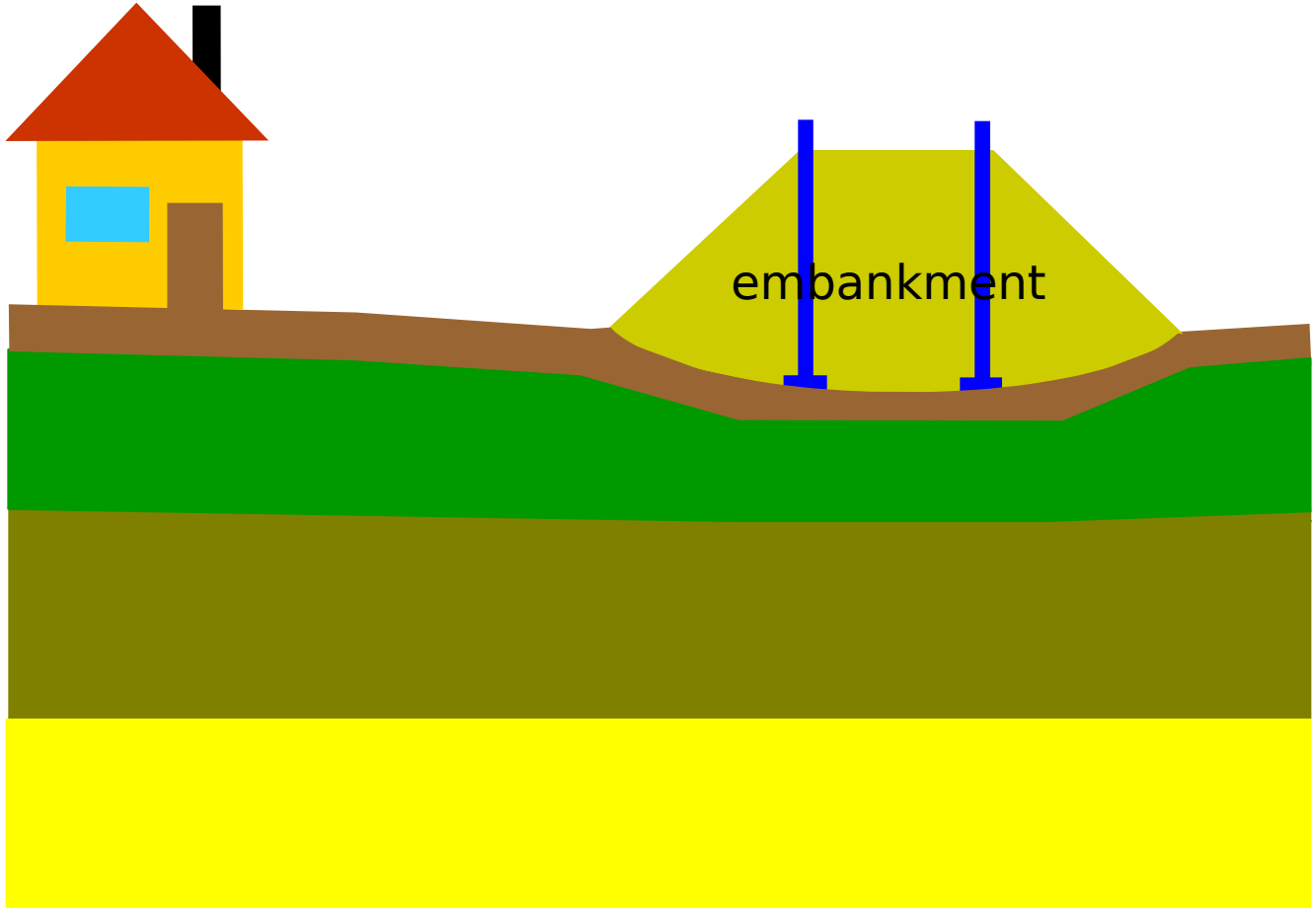
Characteristic	Bourdon	VWP	PR
Accuracy (FS = Full Scale)	1 % FS 20 cm waterkolom	0,15 % FS 5 cm waterkolom	0,1 % FS 2,5 cm waterkolom
Measuring range	2 bar (20 m w.k.)	3,5 bar (35 m w.k.)	2,5 bar (25 m w.k.)
Measuring frequency	Low	Low	High (trillingen)
Barom. ventilation	Yes	No	Yes
Reliability	Moderate	Good	Excellent
Reading	By hand	By hand + automatic	By hand + automatic
Maintenance	Much	Little	Little
Costs	Low	Moderate	High

- **Set-up automatic reading (data logger)**

- **Settlement**
  - Embankment on soft soil (clay and peat)
    - initialy water/pore pressures carry the load of the embankment. No settlement
    - consolidation which results in gradual increase of settlements

- **Instruments to measure settlements:**
  - Settlement plate
  - Settlement tube
  - Measuring pek, bolt or nail

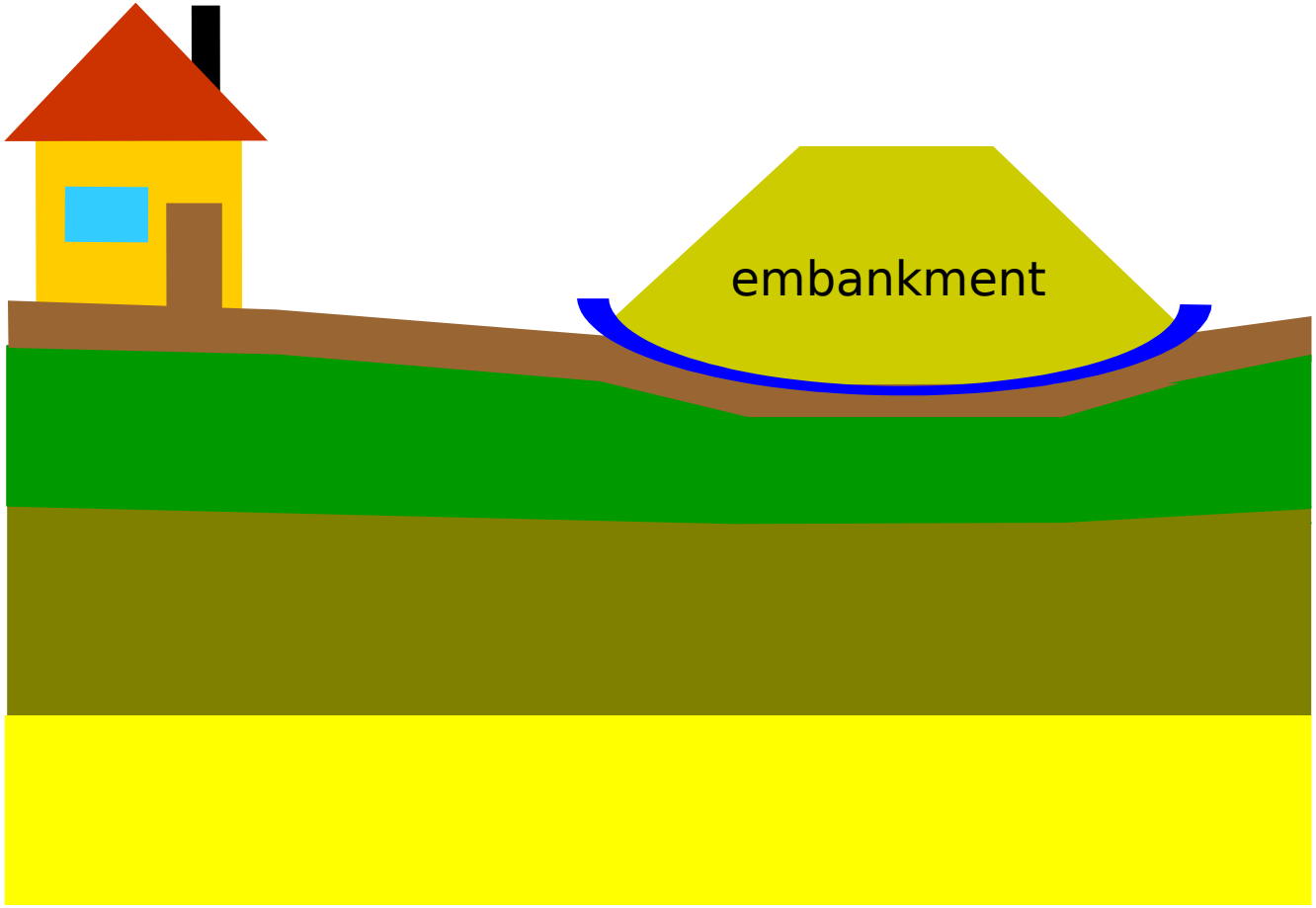
- **Settlement plates**



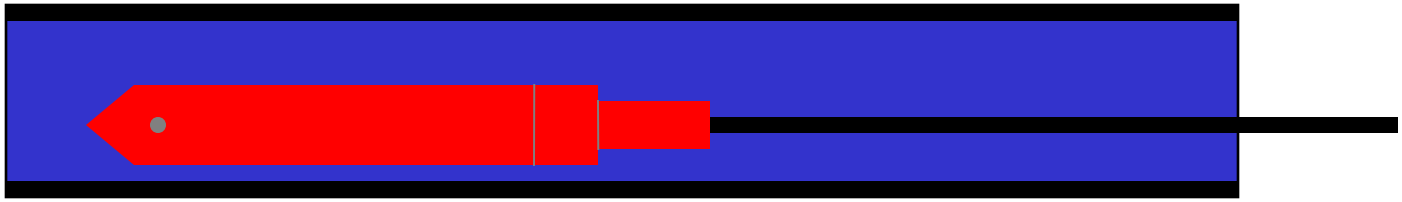
- **Settlement plates**

- **Settlement plates**

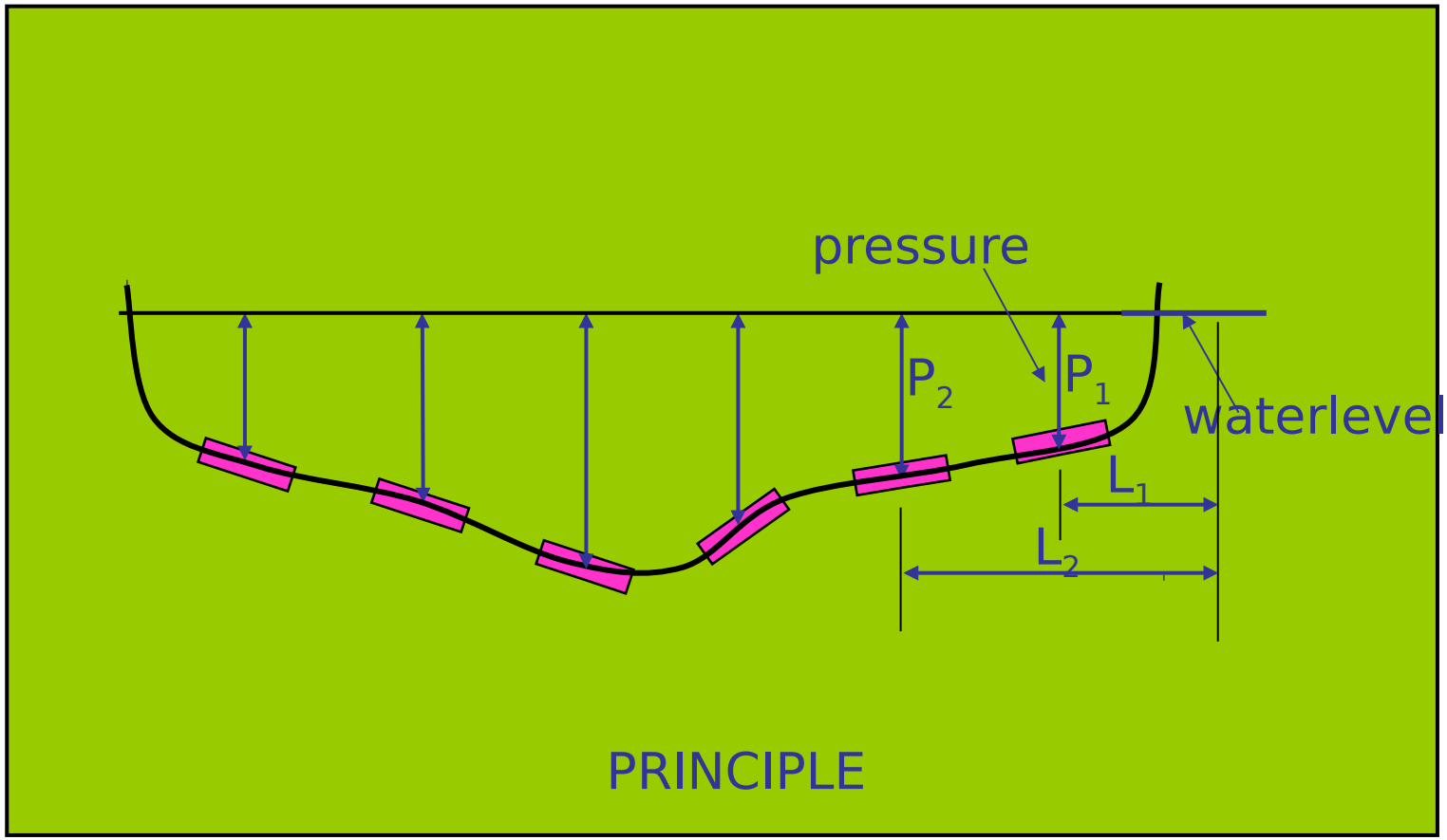
- **Settlement tubes**



- **Settlement tubes**
  - Water/pore pressure meter in settlement tube

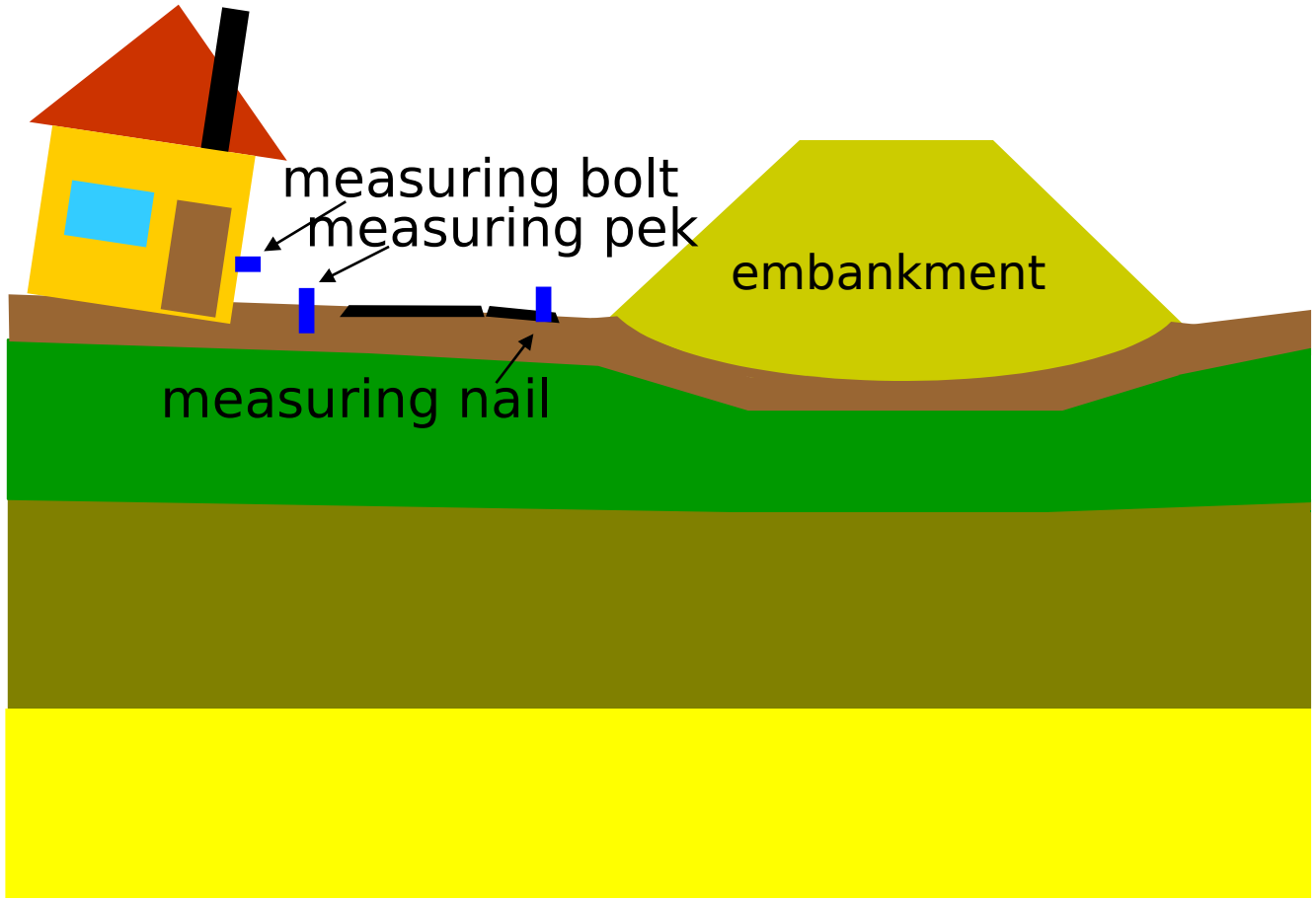


- **Settlement tubes**



- **Settlement tubes**

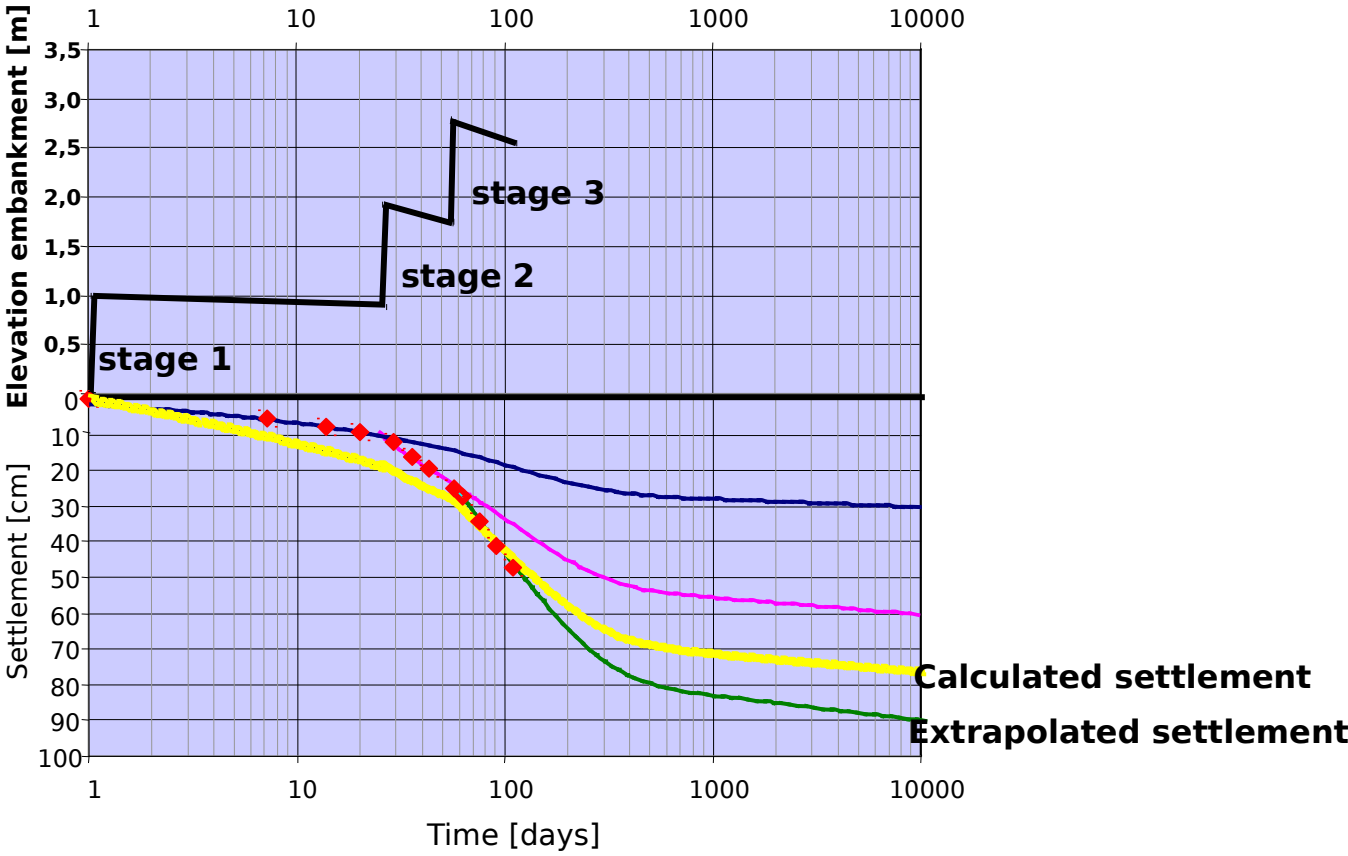
- **Measuring pek, nail or bolt**



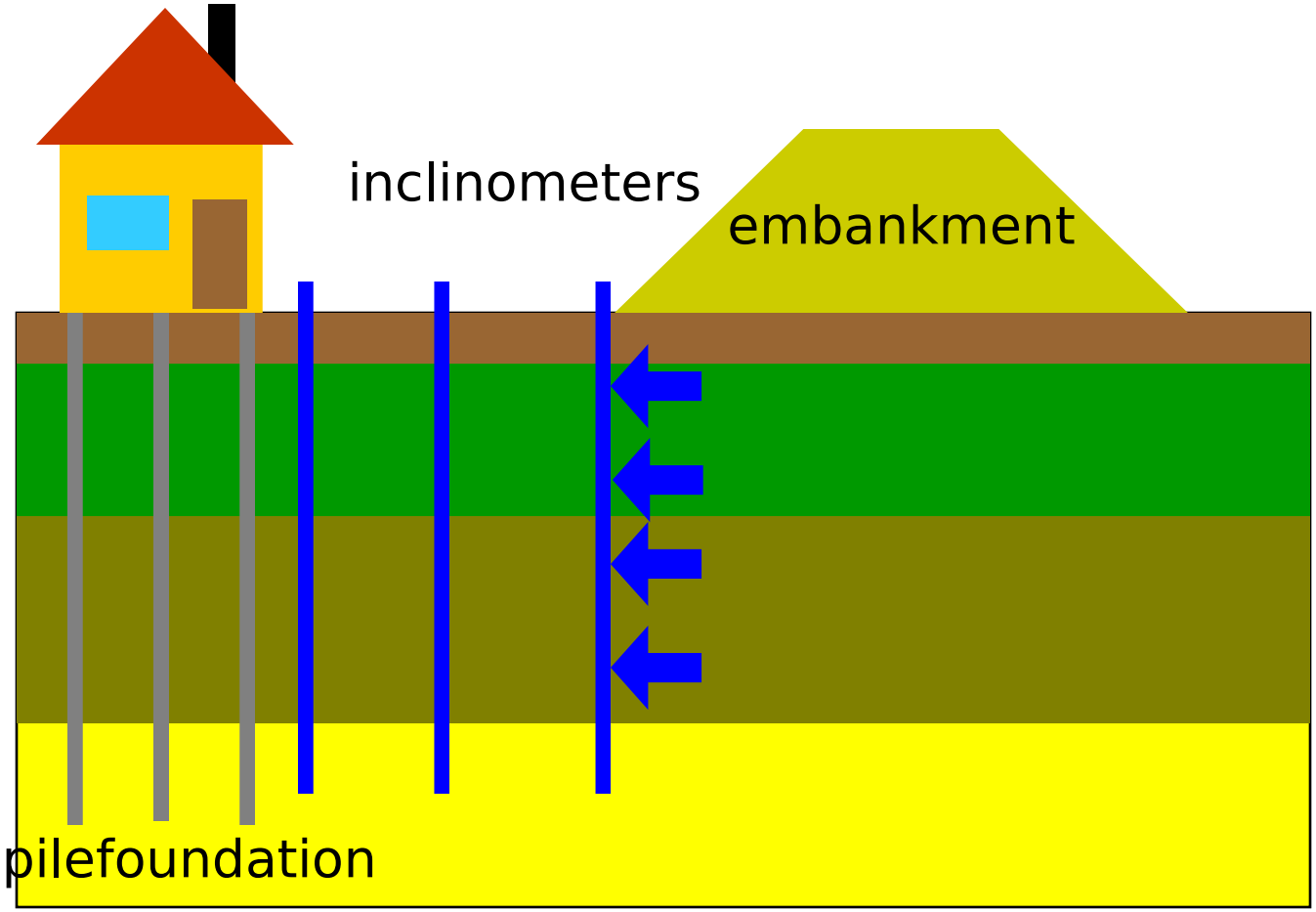
- **Measuring bolt**

- **Procedure for predicting settlement based on measured settlements**
  - Measure settlements
  - Back analyses settlement characteristics based on measurements
  - Extrapolate final settlements
  - Optimize design (if required)

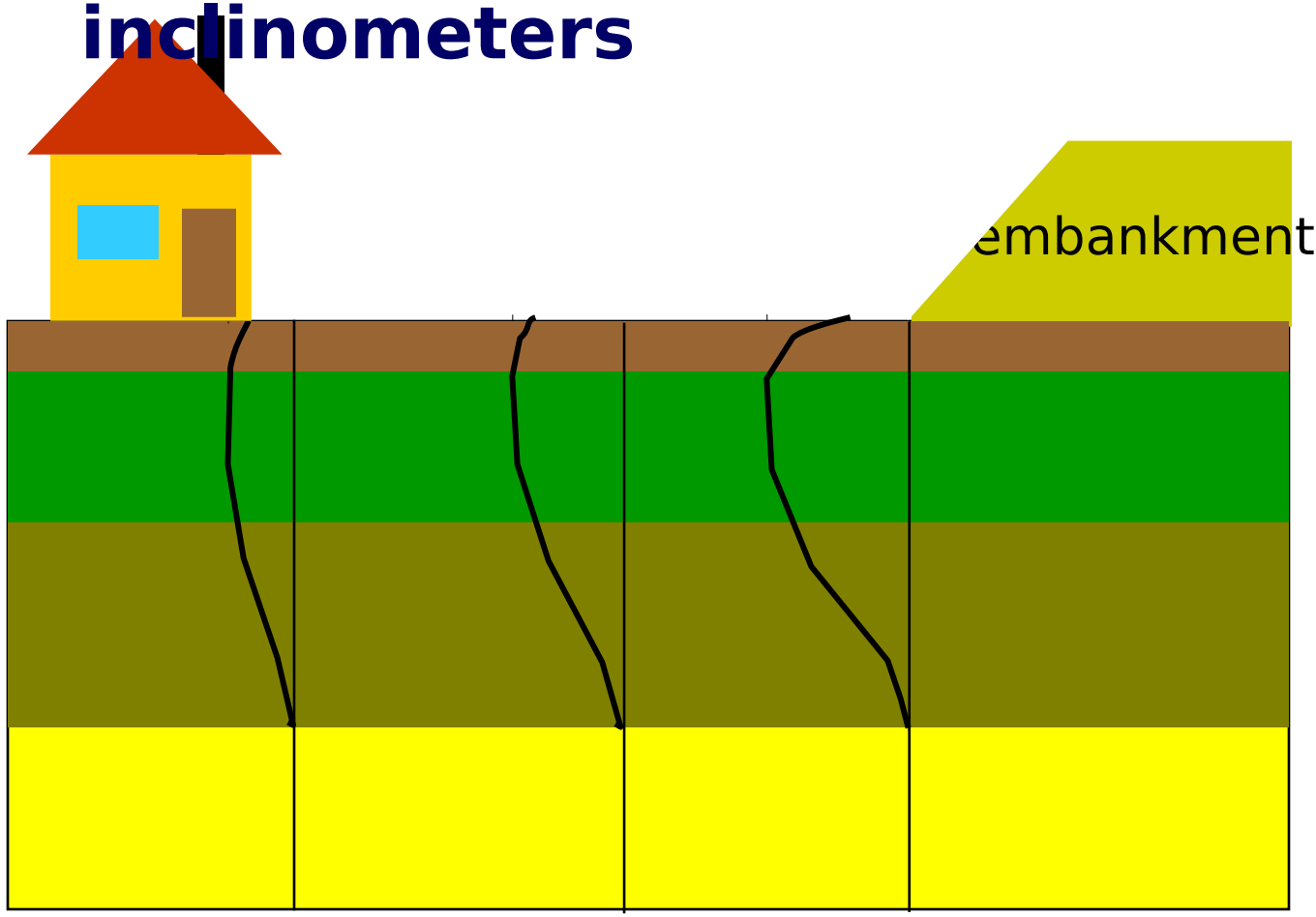
- **Calculated and extrapolated settlements**



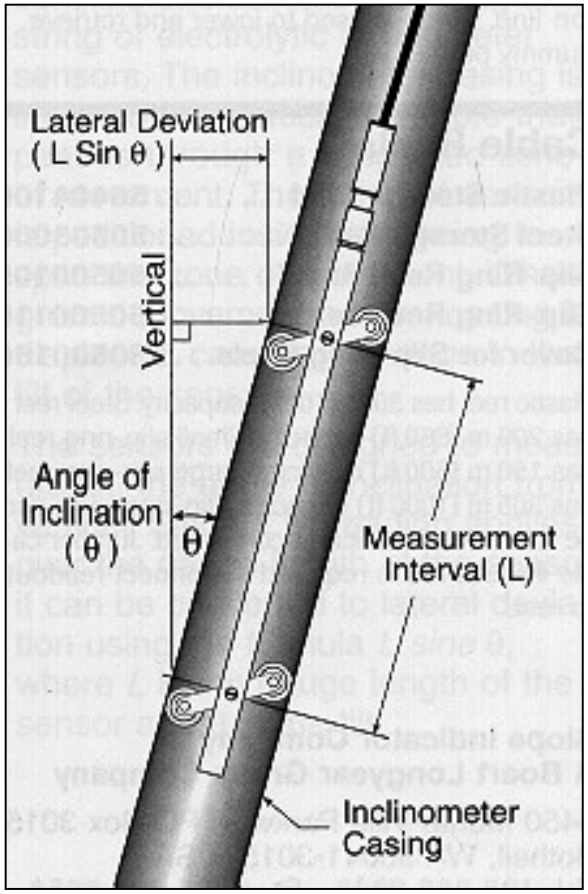
- **Inclinometer**

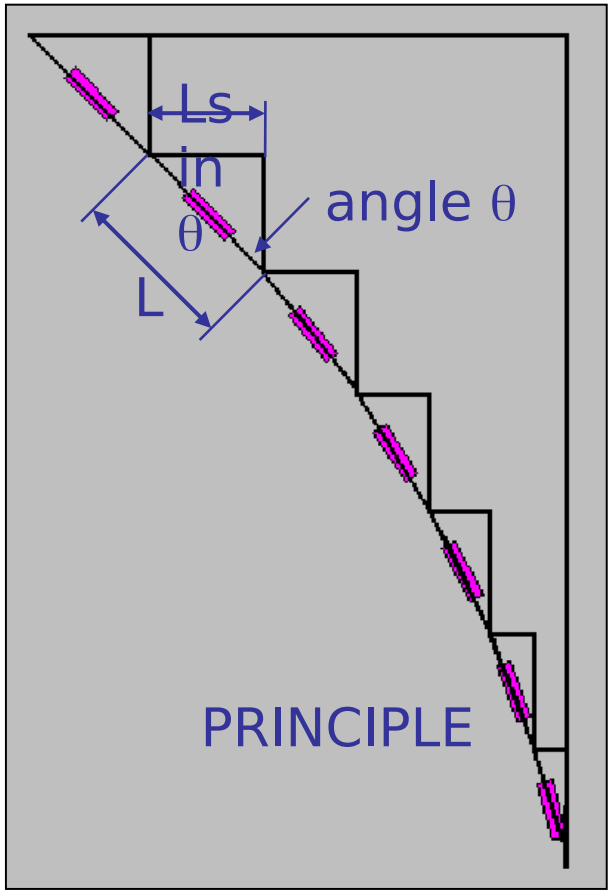


- **Measurements inclinometers**



Inclinometer





- **Measuring inclinometers**

- **Questions/discussion ?**